



## Early Removal of Mango Inflorescences Increase Tree Production and Fruit Quality (*Mangifera indica* L. cv. 'Tommy Atkins')

[28]

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### Abstract

The present investigation was carried out throughout the two successive seasons 2018 and 2019. Mango trees were grown in a private farm located at Wadi Elmullak El-Sharkia Governorate, Egypt. This study aimed to elucidate the impact of pinching early flowering in the winter severity on tree yield and fruit quality of Mango 'Tommy Atkins' cultivar. The old of the mango cultivar under this study was 15 years old and planted as 3x4 m apart grafted on 'Saber' seedling rootstocks, grown in sandy soil and irrigated through drip irrigation system. Mango trees were subjected to deflorescence in mid-February by manual removing emerged inflorescence as follows complete removing (removing of 100% of emerging inflorescences), sever removing (75% of emerging inflorescences), moderated removing (50% of emerging inflorescences), light removing (25% of emerging inflorescences) and control (without removing inflorescences). Results showed that complete removing treatment significantly increased fruit yield as compared with other applications or untreated trees in the two studied seasons. Similar trend was observed regarding yield increment (%) where was superior to control treatment in the two seasons. Moderated and light treatments caused enhancement in some fruit physical properties when compared with 100% or 75% removal treatments. Complete

removing treatment was superior to other treatments regarding total acidity percentage and vitamin C. In conclusion complete removing (100% of emerging inflorescences) in mid-Feb. could be a practicable choice for continued production for the 'Tommy Atkins' under the environmental conditions of exported mango orchards.

**Keywords:** Apical panicles; Application; Flowering; Sever pruning; Variety

### 1 Introduction

Mango (*Mangifera indica* L.) is an important fruit species Admasu et al (2014) cultivated in Egypt it comes in the second rank, after citrus. Egyptian production reached 1091535 tons of fruit in a harvested area 265509 feddan (According to Bulletin the Agriculture Statistics, issued by Ministry of Agric., Egypt 2019). 'Tommy Atkins' Mango tree is a variety originated in Florida, USA. Besides, it's considered as one of the greatest exported cultivars due to its strong shelf life and beautiful greenish red colors (De la Cruz and Garcia 2002). Low productivity is the most important issue faced mango trees industry. Likewise, 'Tommy Atkins' cultivar has been suffering from small output that might be due to early flowering. Moreover, low temperature during blooming has been reported as an important factor in reducing perfect flower per in-

inflorescence (Whiley 1986). Removal of inflorescence at the idea of add-on was shown to induce corresponding re-blooming (Yeshitala et al 2005). Yield of mango trees are depending on a serious limitation such as the date of flower beginning. Pruning by eliminating the inflorescences on Mar. and Apr. were treated on cv. Irwin grown at Wakayama which is regarded as a warm climate area in Japan (Sasaki et al 2000), application induced a flower bud initiation as well as differentiation in the axillary buds (a re-flowering), and a maximum number of inflorescences was gained of panicles those tipping in Mar. (Sasaki et al 2000). "Furthermore, when mango trees are unprotected to winter temperature to induce flowering, flowers development only occurs by warm temperature during winter season which causes early flowering. While, the low temperature during flowering period decreases the perfect flowers percentage, number of flowers per panicle and length of inflorescences" (Whiley 1986). Warm periods through winter season might be allow early emerged inflorescence to happen in all mango cultivars. This might be injured by following cold temperature (Litz 2009). Sasaki et al (2000) found that removing terminal panicles induced axillary flower buds of mango cultivar 'Irwin'. Single de-inflorescence application induced highly rise in tree yield in comparison to untreated mango (Singh et al 1974).

Removing inflorescence increased fruit set percentage, yield and fruit size per trees of mango 'Cogshall' cv., (Jannoyer and Lauri 2009). "A delay in flowering is usually considered advantageous, meanwhile inflorescence development when temperatures are higher, resulted in a rise within the proportion of perfect as against male flowers formed" (Mullins 1986), and provided increase to more effective fertilization (Robbertse et al 1986; Shu et al 1989; Issarakraisila ; Considine 1994). Tipping the apical inflorescences of Mango 'Hindi Besinara' cultivar trees twice at the first and third week of Feb. enhanced the percentage of perfect flowers per inflorescence and fruit retention (Elkhishen 2015). Mango tree flowering is

a vital phenological stage that playing an important role in production and yield. 'Tommy Atkins' cultivar is suffering from low productivity that might be due to early flowering. The impact of low temperature during early blooming period has been reported as a reason that reduce perfect flower in inflorescence. High temperature throughout winter season might be induce early emerged inflorescence to happen in all mango cultivars. This might be injured by following cold temperature. Therefore, this study aimed to elucidate the impact of early removing inflorescence in the winter severity on tree productivity and fruit physical and chemical properties of Mango 'Tommy Atkins' cv.

## 2 Materials and Methods

### 2.1 Plant materials and experimental application

This investigation was done in 2018 and 2019 seasons on mango trees (*Mangifera indica* L.) 'Tommy Atkins' cv. The study performed in a private farm located at Wadi Elmullak El-Sharkia Governorate, Egypt. The mango trees were 15 years old, planted at 3x5 m apart, grafted on 'Saber' rootstock, grown in sandy soil and irrigated through drip irrigation system. All trees received similar cultural practices. Forty five trees (similar in vigor and healthy) were chosen for investigation. Mango trees were subjected to five deinflorescences level treatments in mid-Feb. by manual removing emerged inflorescences as follows:

Control (without removing inflorescences).

Light removing (removing 25% of emerging inflorescences).

Moderated removing (removing of 50% of emerging inflorescences).

Sever removing (removing of 75% of emerging inflorescences).

Complete removing (removing 100% of emerging inflorescences).

Each manual removing emerged inflorescence treatment had three replicates with three trees per a replicate. The maturity stage was determined at

fruit age 109 day in Tommy Atkins cv. according to Khalefa (2006). Complete randomized block design was followed according to Snedecor and Cochran (1980).

## 2.2 Measurements

### 2.2.1 Tree yield

Fruits of trees were harvested at maturity stage, (fruit at age 109 day in Mango Tommy Atkins cv. according to Khalefa (2006), and separately weighed therefore. The yield (Kg/tree) was calculated in mango cultivar in the both seasons. Moreover, yield increment than untreated treatment percentage was calculated by using El-Naby et al (2019) equation.

Yield increase than control (%) =  $\frac{\text{Yield (treatment)} - \text{Yield (control)} \times 100}{\text{Yield (control)}}$

### 2.2.2 Physical and biochemical characteristics of fruit

#### 2.2.2.1 Fruit physical properties

Five fruits of each mango tree replicated 3 times were devoted and picked during harvest date, then determining some of fruit parameters, such as weight and volume of fruit, fruit dimensions (length and width) as well as weight of fruit peel and pulp.

Firmness of fruit expressed as (lb./inch<sup>2</sup>) was measured using pressure tester (digital force-Gouge Model IGV-O.SA to FGV-100A.Shimpo instruments).

#### 2.2.3 Fruit chemical properties. The following parameters were recorded

Fruit total soluble solids (TSS %) from the sample's fruit pulp was determined by using a digital refractometer.

Titrateable acidity percentage (TA) was determined by titration and expressed as citric acid according to A.O.A.C. (2005).

Total soluble solids/acid ratio was estimated from the values of total soluble solids divided by values of total acids.

Ascorbic acid (Vitamin C) was estimated by titrating fruit juice sample with 2, 6 dichlorophenol indophenol dye according to A.O.A.C. (2005).

Fruit total sugar content was determined colorimetrically in fruit dry weight (g / 100 g dr. wt.) according to the method of Miller (1972).

Statistical Analysis: The analysis of variance (ANOVA) was performed using one way ANOVA Co-stat software according to Stern (1991) and the means were differentiated using Duncan multiple range test at 5% level (Waller and Duncan 1969).

## 3 Results and Discussion

### 3.1 Tree yield

The results in **Table 1** clearly showed that all applied removing inflorescences treatments to mango tree cv. 'Tommy Atkins' significantly increased fruits number per tree and fruit yield (kg/tree) when compared with control in the two studied seasons 2018 and 2019. The best results regarding removing of emerging inflorescence in mango trees were gained when complete removing (100 % of inflorescence were removed), followed descending order by severe removing, moderate removing and slight removing. On the other hand, the lowest fruit number and fruit yield (kg per tree) were recorded when mango trees they received treatment (control). Similar trend was observed regarding yield increment (%) where was superior to untreated treatment in the both seasons. From the early removing trials of the two studied seasons it may be concluded that the yield of large mango cv. 'Tommy Atkins' is about doubled. These results are in harmony with those obtained by Shaban (2005) who found that the number of emerged axillary panicles in 'Hindi Besinnara' cultivar significantly increased by early removing apical panicle treatment. Similarly, Yeshitela et al (2005) found that removing mango blossom early in the growth season had increased number of reproductive inflorescences per trees in Tommy Atkins cultivar. Also, Samra et al (2010) found

that pinching of early flowering Zebda Mango tree at first emergence on trees from mid-Dec. to mid-Feb. may be significantly enhanced tree yield comparing to the control. Ali (2014) found that pruning of malformed inflorescences increased yield of the fruits than control treatment of 'Hindy Be- sinnara', 'Ewis' and 'Sedik' mango trees. Likewise, Elkhishen (2015) mentioned that removing the apical blossom of mango cultivar 'Hindi Besinnara' at the first and third week of Feb. improved significantly the fruit yield per tree.

The higher fruit numbers that recorded in compelet removing treatment (**Table 1**), "might be attributed to the increase in fruit retention after re-flowering. Favourable higher temperature during the growth of the different parts of the flowers caused the higher fruit setting in turn" (Yeshitela 2005). The increments in fruit (number and the yield per tree) by removing inflorescence was in agreement with Shaban (2005) who reported that heading back or pinching 'Hindi Besinnara' mango trees in December recorded the maximum No. of fruits per tree. The enhancing effects of early inflorescence removal by winter might be attributed to enhancing number of panicles developing per terminal panicle (Oosthuysen and Jacobs 1997). Samra et al (2010) found that pinching of early flowering Zebda Mango tree in December or January was the most effective treatment for increasing number of fruits / tree comparing to the control. Sarkhosh et al (2018) found that tip-pruning applied in Feb. increased canopy flowering percentage, No. of fruits/tree and fruit weight of mango tree cv. Honey Gold compared with control.

It could be concluded that applied early removing panicles treatments to mango trees in mid-February caused an increase in yield per tree in compared with those of untreated and opposite treatments.

### **3.2 Effect of removing severity of the emerging inflorescences on some fruit physical characteristics**

#### **3.2.1 Fruit weight, volume and dimensions (length and width)**

The results in **Table 2** showed that moderated removing, light removing and control treatments significantly increased fruit (weight and volume) as well as dimensions of fruit (length and width), of mango 'Tommy Atkins' cultivar when compared with compelet or sever removing treatments in the first season. The increasing of fruit weight in removing treatments might be due to an improved microclimate and higher photosynthetic rates (Sharma and Singh 2006). On the other hand this trend had not observed in the second season. Maximum fruit weight was recorded in control treatment. The rise in weight of fruit in control treatment might be attributed to the lowest number of mango fruits per tree (**Table 1**). These findings are in harmony with those gained by Yeshitela (2005) who found that removing 50% of the panicles increased fruit weight and size of 'Sensation' mango cultivar. Moreover, fruit thinning, by reducing competition for carbohydrates between fruits (Horscroft ; Sharples 1987; Yeshitela 2004). The same trend was observed regarding peel weight, pulp weight and seed weight when compared with compelet or sever removing treatments. Ali (2014) found that pruning of malformed inflorescences improved physical parameters of the fruits than control treatment of 'Hindy Besinnara', 'Ewis' and 'Sedik' mango trees.

#### **3.2.2 Fruit firmness**

Results in **Table 2** also cleared that all tested removing treatments significantly increased fruit firmness of mango 'Tommy Atkins' cultivar in comparison to control in the two seasons. Insignificant difference in fruit firmness was noticed between treatments in the first season except

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**Table 1.** Effect of removing severity of the emerging inflorescences on yield characteristics (kg/tree) of Mango 'Tommy Atkins' cv. trees during seasons 2018 and 2019

Treatments	Fruits number /tree	Yield (kg/tree)	Yield increase than control (%)	Yield (ton)/ feddan
Season 2018				
Control	16.00 e	10.23 d	0.0 d	2.86 c
Light removing	24.00 d	15.93 c	55.9 c	4.46 b
Moderated removing	27.33 c	18.51 b	79.7 b	5.09 b
Sever removing	39.67 b	18.38 b	81.5 b	5.15 b
Complete removing	60.00 a	25.89 a	153.5 a	7.25 a
Season 2019				
Control	25.00 e	18.02 c	0.0c	5.05 c
Light removing	51.67 d	29.56 b	64.0 b	8.28 b
Moderated removing	61.00 c	30.65 b	70.2 b	8.58 b
Sever removing	73.33 b	32.16 b	78.6 b	9.01 b
Complete removing	96.87 a	42.90 a	137.6 a	11.08 a

Means followed by the same letter (s) in each column are not significantly different at 5 % level.

**Table 2.** Effect of removing severity of the emerging inflorescences on some physical characteristics of 'Tommy Atkins' mango cv. during 2018 and 2019 seasons

Character. Treatments	Fruits weight (gm)	Fruits volume cm <sup>3</sup>	Fruit length (cm)	Fruit width (cm)	Peel weight (g)	Pulp Weight (g)	Seed weight (g)	Firmness lb/ inch <sup>2</sup>
Season 2018								
Control	669.2 a	680.0 a	13.9 ab	9.4 ab	95.1 ab	512.4 a	57.3 b	24.6 b
Light removing	664.8 a	665.0 a	14.4 a	10.0 a	93.8 b	503.0 a	72.4 a	33.7 a
Moderated removing	645.7 a	583.3ab	14.2 ab	9.7 ab	97.6 a	481.8 a	66.3 a	36.5 a
Sever removing	464.2 b	516.7ab	12.9 b	8.7 b	59.0 c	352.2 b	53.0 b	38.2 a
Compelet removing	431.6 b	426.7 b	11.4 c	7.8 c	47.6 d	343.4 b	40.6 c	39.3 a
Season 2019								
Control	721.8a	666.7a	14.0 a	9.4 a	93.4 a	561.1 a	67.2 a	21.2 c
Light removing	572.4b	516.7b	13.7 a	9.0 a	80.8 b	428.6 b	63.1 a	30.2 b
Moderated removing	502.6bc	416.7c	12.1 ab	8.4 a	83.1 b	372.0 b	47.4 b	33.2 ab
Sever removing	438.6cd	403.3c	12.4 ab	8.2 a	48.5 c	348.0 b	42.1 b	35.5 a
Compelet removing	371.0d	306.7d	10.8 b	6.5 b	35.5 d	305.0 b	30.4 c	36.0 a

Means followed by the same letter (s) in each column are not significantly different at 5 % level.

in control. Maximum value of fruit firmness percentage was obtained with compelet removing treatments. The increase in fruit firmness with trees that received the inflorescences removing treatments might be due to inducing for synchronisation of re-flowering. "It is predictable that compelet removing treatment could had raised nutrient uptake of soil, as well as changed activities of enzyme, anatomy of fruit and fruit shape index. Complete early removing mediated raise calcium translocation is also stated in apple fruits. The presence of calcium in fruit known to support the middle lamella and lower the activities of cell wall-degrading enzyme such as pectin methylesterase and polygalactouronase" (Asrey et al 2013). These trees also attained late fruit set and more fruit per panicle than the opposite panicle pruning treatment Yeshitela (2004). "Firmness of fruit is a multifactorially-influenced phenomenon viz. size of fruit, number and size of cells, volume of intercellular space, fruit shape index, harvest maturity, minral content and enzyme activity" (Link 2000).

We can conclude that applying early removing emerging inflorescences treatments to 'Tommy Atkins' mango trees in mid-February caused improvement in the tasted physical properties in comparison to those of control.

### 3.3 Effect of removing severity of the emerging inflorescences on some fruit chemical characteristics

#### 3.3.1 The percentage of TSS, Total acidity, vitamin C and total sugars

The results in **Table 3** cleared that compelet removing of emerging inflorescences treatment significantly dcreased total soluble solids % (TSS%), TSS/acid ratio and total sugars (%) of mango fruits 'Tommy Atkins' cv., when compared with other treatments or control. Whearase total acidity% and ascorbic acid (vitamin C) showed an opposite trend sice they passed higher than values than control in the two seasons. The higher recovery of fruits total soluble solids percentage from unremoved mango trees

could be due to quicker carbohydrates degradation in comparison to fruits from tipped mango trees. These results are in agreement with those gained by Asrey et al (2013) who reported that a moderately more significant level of total soluble solids and lower level of of total acidity was recorded both in developed green and matured fruits gathered from untipping mango trees. "Fruit organic acids the synthesis and accumulation are influenced by numerous factors, the most important ones are phytohormon and the canopy microclimate. The organic acids level becomes more pronounced throughout the initial fruit development period" (Chen et al 2009).

The maximum values of (TSS%) and T.S.S / acid ratio were obtained with untreated mango trees. These findings are in agreement with results of Lakshminarayana (1980) who clarified that the total organic acids of fruit decreased during physiological fruit ripening stage. T.S.S/acid ratio has been used to assess the flavor of fruit (Oliveira 2017), as it increased by fruit ripening. Chitarra and Chitarra (2005) reported that the decrease in fruit acidity by ripening physiological stage, induces an important role in the fruit acid: sugar stability therefore, in influencing the fruit chemical properties (taste and flavor). The increasing in vitamin C in fruit as well as fruit total acidity percentage at the end of grown season (harvest time) might be due to the rise in growth caused by panicles pruning treatments (Yeshitela 2005).

The results also showed that a definite trend could be drawn between apicale removing treatments and their severity. Hence, mango tree that received compelet removing treatment gained the maximum values of both total acidity % and ascorbic acid (vitamin C) parameters, follwed by sever removing and moderated removing treatments. Ali (2014) found that pruning of malformed inflorescences improving chemical parameters of the fruits than control treatment of 'Hindy Be- sinnara', 'Ewis' and 'Sedik' mango trees. Meanwhile the fruit maturity physiological stage under removed treatment situations arrived late in our investigation, the reason for higher titratable acidity in removed situations is fairly

**Table 3.** Effect of removing severity of the emerging inflorescences on some chemical characteristics of mango 'Tommy Atkins' cv., during 2018 and 2019 seasons

Character. Treatments	T.S.S (%)	Total acidity (%)	T.S.S / acid ratio	V.C mg/100 ml of pulp juice	Total sugars (%)
Season 2018					
Control	11.0 a	2.2 c	4.7 a	38.7 c	7.48 a
Light removing	10.7 a	2.6 bc	3.9 b	39.7 c	7.25 a
Moderated removing	9.3 a	2.7 bc	3.3 bc	43.4 b	6.35 ab
Sever removing	9.0 a	2.8 b	3.0 c	42.8 b	6.12 b
Compelet removing	7.0 b	3.0a	2.0d	47.2 a	4.47 c
Season 2019					
Control	12.0 a	2.6 b	4.6 a	38.7 e	8.17 a
Light removing	11.7 a	2.9 ab	4.0 b	40.6 d	7.79 a
Moderated removing	10.7 ab	3.2 a	3.3 c	41.6 c	7.27 ab
Sever removing	9.6 b	3.3 a	2.9 c	44.4 b	6.53 b
Tipping removing	6.7 c	3.4 a	2.0 d	46.3 a	4.57 c

Means followed by the same letter (s) in each column are not significantly different at 5 % level.

obvious. It could be concluded that applying early removing emerging inflorescences treatments to 'Tommy Atkins' mango trees in mid-February caused a decrease in both total soluble solids % , total soluble solids /acid ratio as well as total sugars % of mango fruits and an increase in (vitamin C) and titratable acidity % in comparison to those of control.

#### 4 Conclusion

In conclusion our observations suggested that the issue of mango removal inflorescence is need further studies to evaluate the continuous effect of this treatment on mango tree yield and fruit quality. Removing treatments applied to 'Tommy Atkins' mango trees in mid-February caused an increase in tree yield and improved physical and chemical properties in comparison to those of control. Hence, compelet removing (removing of 100% emerging inflorescences) in mid-February could be a practical opportunity for continued yield of the 'Tommy Atkins' mango farms.

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## الخف المبكر لنورات المانجو الزهرية يزيد من إنتاج الشجرة وجودة الثمار لصنف "تومي اتكينز"

[28]

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### الموجز

والقصف المعتدل (تقصف 50% النورات الزهرية المنبتقة) والقصف الخفيف (تقصف 25% النورات الزهرية المنبتقة) ثم معاملة الكنترول (بدون اجراء خف لاي من النورات الزهرية المنبتقة). أوضحت النتائج ان معاملة الخف الكامل للنورات الزهرية المنبتقة أدت الى زيادة معنويه في محصول الأشجار (بالكيلوجرام/شجرة) مقارنة بالمعاملات الأخرى ومعاملة الكنترول. أدت معاملات كلا من الازالة الخفيفة والمتوسطة الى تحسين بعض من الصفات الطبيعية للثمار مقارنة بمعاملات الخف بنسبة 100% او 75% وتوقفت معاملات الخف الكامل على بقية المعاملات في النسبة المئوية للحموضة الكلية بالثمرة وفيتامين ج . يمكن الاستنتاج ان معاملة القصف الكامل (بنسبة 100% من النورات لزهريه المنبتقة ) في منتصف شهر فبراير يمكن ان يكون خيارا قابل للتطبيق للإنتاج المستدام للمانجو صنف تومي اتكينز تحت الظروف البيئية لبستان المانجو للتصدير .

أجريت هذه الدراسة خلال موسمين متتاليين 2019/2018 على أشجار مانجو منزرعة في بستان خاص يقع في منطقة وادى الملاك بمحافظة الشرقية. وهدفت هذه الدراسة الى دراسة تأثير شدة التطويش للازهار المبكرة في الشتاء على المحصول وجودة ثمار المانجو صنف "تومي اتكينز" . بلغت الأشجار محل الدراسة عمر 15 سنة وعلى مسافات زراعة 3\*4 م ومطعومة على الأصل البندى (Saber) ونامية في أرض رملية وتروى باستخدام نظام الري بالتنقيط. عرضت أشجار المانجو محل الدراسة لإزالة النورات الزهرية في منتصف شهر فبراير في كلا من الموسمين بإزالة النورات الزهرية يدويا كالتالى: القصف الكامل (تقصف 100% من النورات الزهرية المنبتقة) والقصف الشديدة (تقصف 75% النورات الزهرية المنبتقة)